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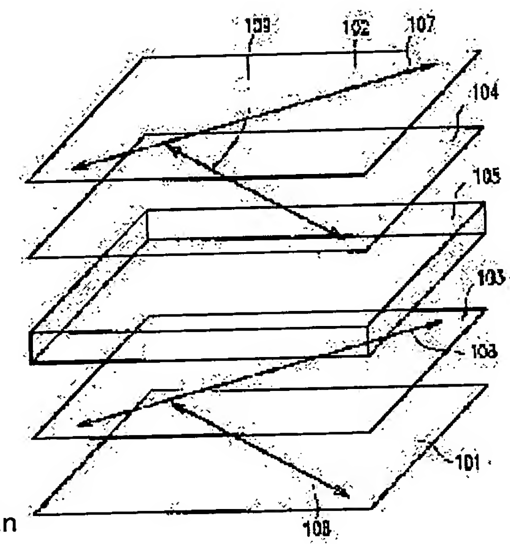
(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To improve a view angle characteristic by making a value of local refractive index anisotropy in a plane parallel to a liquid crystal cell surface at a black displaying time smaller than that at a white displaying time, making a phase difference compensation element show the refractive index anisotropy and specifying refractive indexes in the directions along respective main axes of an orthogonal frame of reference.
SOLUTION: The phase difference compensation elements 103, 104 are provided between polarizing plates 101, 102 holding a liquid crystal cell 105 between them and arranged in orthogonal Nicol and the liquid crystal cell 105. Then, the value of the local refractive index anisotropy in the plane parallel to the liquid crystal cell 105 surface at the black displaying time is made smaller than that at the white displaying time. Further, the phase difference compensation elements 103, 104 show the refractive index anisotropy, and when the refractive indexes along respective main axes of the orthogonal frame of reference are defined nx>nz, and the main axis (z) is paralleled to the normal of the liquid crystal cell surface, and the main axes (x), (y) exist in the plane parallel to the liquid crystal cell surface, nz<(nx+ny)/2. and nx>ny. Thus, the deterioration in the view angle characteristic due to deviation from absorption axes is prevented, and an axial symmetry characteristic is obtained.



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CLAIMS

[Claim(s)]
[Claim 1] The liquid crystal cell which has the liquid crystal layer pinched by the substrate of a couple, and the polarizing plate of a couple with which the crossed Nicol has been arranged while pinching this liquid crystal cell, If it has the phase contrast compensation element prepared at least in one side between the polarizing plate of this couple, and this liquid crystal cell and is in this liquid crystal layer While the direction at the time of a black display has the value of the local refractive-index anisotropy within a field parallel to this liquid crystal cell front face smaller than the time of a white display and the aforementioned phase contrast compensation element presents a refractive-index anisotropy When defining it as setting the refractive index of the direction in alignment with the main shaft x of a rectangular coordinate system XYZ, y, and the z-axis to nx, ny, and nz, and the main shaft z being parallel to the normal on this front face of a liquid crystal cell, and a main shaft x and y having it in a field parallel to this liquid crystal cell front face, The liquid crystal display which are nz< (nx+ny)/2 and nx>ny.
[Claim 2] The liquid crystal display according to claim 1 which has the 1st and 2nd phase contrast compensation elements between the polarizing plate of the aforementioned couple, and the aforementioned liquid crystal cell, respectively.
[Claim 3] It is the liquid crystal display according to claim 1 or 2 whose phase contrast compensation films of another side one side of the phase contrast compensation films of two sheets arranged on one side of the aforementioned liquid crystal cell by the aforementioned phase contrast compensation element consisting of a phase contrast compensation film of two sheets, respectively is nx=ny and nz<nx, and are ny=nz and nx>ny.
[Claim 4] the refractive-index anisotropy of the above 1st and the 2nd phase contrast compensation element -- abbreviation -- the same liquid crystal display according to claim 2 or 3
[Claim 5] Any of claims 2-4 in which each main shaft x of the above 1st and the 2nd phase contrast compensation element is carrying out the abbreviation rectangular cross mutually, or the liquid crystal display of a publication.
[Claim 6] A liquid crystal display given in any of claims 1-5 whose angle with the shaft with which each phase contrast compensation element and the main shaft x of the aforementioned phase contrast compensation element cross at right angles at the absorption shaft of the polarizing plate of the nearest neighbors to accomplish is **45 degrees they are.
[Claim 7] The liquid crystal display in which the main shaft x of the aforementioned phase contrast compensation element carries out an abbreviation rectangular cross on the absorption shaft of the polarizing plate of the nearest neighbors at each phase contrast compensation element.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to a liquid crystal display. It is related with the liquid crystal display which has the wide-field-of-view angle property of being used suitable for the display which used flat-surface displays and the shutter effects, such as a personal computer, a word processor, an amusement device, and a TV apparatus, especially.
[0002]
[Description of the Prior Art] The method for which a liquid crystal molecule is made to exercise in general in parallel to a substrate front face as the technique of wide-field-of-view cornification of a liquid crystal display, and movement of a liquid crystal molecule have the method which divides the orientation in one picture element into plurality to a substrate front face while it has been perpendicular. installation-performance-specification (In-Plane Switching) mode is mentioned as a former typical method. The wide-field-of-view angle liquid crystal display mode in which level orientation of the Np type liquid crystal (nematic-phase positive-type liquid crystal) was carried out to the shape of an axial symmetry as an example of the latter method (JP,7-120728,A), The wide-field-of-view angle liquid crystal display mode which carries out division orientation of the Nn type liquid crystal (nematic-phase negative-mold liquid crystal) which carried out perpendicular orientation by electric-field control at the time of operation (JP,7-28068,A), And the wide-field-of-view angle liquid crystal display mode which was indicated by AM-LCD'96 and p.185 (1996) and to which abbreviation quadrisection was carried out and level orientation of the Np type liquid crystal was carried out within the picture element is proposed.
[0003]
[Problem(s) to be Solved by the Invention] By the way, in the display mode which divides the orientation in the picture element which is the latter method, generally, as shown in drawing 22 and drawing 23 , there was a problem that the angle-of-visibility property in the shaft orientations which bisect the absorption shaft 202 of an upper polarizing plate and the absorption shaft 203 of a lower polarizing plate which were established on both sides of the liquid crystal cell 201 became remarkably bad as compared with the angle-of-visibility property of absorption shaft orientation. That is, if the spherical coordinate system which set to theta the angle of visibility which is the angle seen from the normal of the virtual flat surface 204 parallel to the liquid crystal cell for defining an angle of visibility as shown in drawing 22 (a), and made Azimuth phi the angle from the absorption shaft 203 (you may be phi = 0 degree) of the lower polarizing plate of a direction to see is defined and an angle-of-visibility property is evaluated, a ** contrast contour curve will become like the curve 301 which is not concerned with a display mode but is generally shown in That is, there was a problem that an angle of visibility became narrow as Azimuth phi shifted from the absorption shaft of a lower polarizing plate the top. In addition, the curve 302 in drawing 23 shows a contrast contour curve, such as aiming at obtaining in this invention.
[0004] this invention is made that the technical problem of such conventional technology should be solved, cancels aggravation of the angle-of-visibility property accompanying the gap from an absorption shaft, and aims at offering the liquid crystal display which has the angle-of-visibility property of an axial symmetry in general.
[0005]
[Means for Solving the Problem] The liquid crystal cell which has the liquid crystal layer in which the liquid crystal display of this invention was pinched by the substrate of a couple, The polarizing plate of a couple with which the crossed Nicol has been arranged while pinching this liquid crystal cell, If it has the phase contrast compensation element prepared at least in one side between the polarizing plate of this couple, and this liquid crystal cell and is in this liquid crystal layer While the direction at the time of a black display has the value of the local refractive-index anisotropy within a field parallel to this liquid crystal cell front face smaller than the time of a white display and this

phase contrast compensation element presents a refractive-index anisotropy When defining it as setting the refractive index of the direction in alignment with the main shaft x of a rectangular coordinate system XYZ, y, and the z-axis to nx, ny, and nz, and the main shaft z being parallel to the normal on this front face of a liquid crystal cell, and a main shaft x and y having it in a field parallel to this liquid crystal cell front face, It is nz< (nx+ny)/2 and nx>ny, and the above-mentioned purpose is attained by that.

[0006] Between the polarizing plate of the aforementioned couple, and the aforementioned liquid crystal cell, it is good also as composition which has the 1st and 2nd phase contrast compensation elements, respectively.

[0007] One side of the phase contrast compensation films of two sheets arranged on one side of the aforementioned liquid crystal cell by the aforementioned phase contrast compensation element consisting of a phase contrast compensation film of two sheets, respectively is nx=ny and nz<nx, and the phase contrast compensation film of another side is good also as composition which is ny=nz and nx>ny.

[0008] the refractive-index anisotropy of the above 1st and the 2nd phase contrast compensation element -- abbreviation -- it may be the same

[0009] Each main shaft x of the above 1st and the 2nd phase contrast compensation element may be carrying out the abbreviation rectangular cross mutually.

[0010] The angle with the shaft with which each phase contrast compensation element and the main shaft x of the aforementioned phase contrast compensation element cross at right angles at the absorption shaft of the polarizing plate of the nearest neighbors to accomplish may be **45 degrees.

[0011] The main shaft x of the aforementioned phase contrast compensation element is good for each phase contrast compensation element also as composition which carries out an abbreviation rectangular cross at the absorption shaft of the polarizing plate of the nearest neighbors.

[0012] Below, it explains per operation of this invention.

[0013] As this invention is shown in drawing 1 , the average refractive index within a field parallel to a liquid crystal display cell front face (nx, ny) is large compared with the refractive index (nz) of the thickness direction, and the phase contrast compensation element which has a refractive-index anisotropy (nx>ny) in a field is inserted between a liquid crystal cell and a polarizing plate. Then, aggravation of the angle-of-visibility property accompanying the gap from the absorption shaft of a polarizing plate will be canceled.

[0014] The conditions about the refractive index of the phase contrast compensation element used by this invention are nz< (nx+ny)/2 and two conditions which become nx>ny as they are shown in drawing 1 . In addition, even if it is the case where a phase contrast compensation element is constituted from two or more phase contrast boards (or phase contrast film), the two above-mentioned condition should just be fulfilled as the whole element. In addition, 401 in drawing 1 shows the phase contrast compensation element used by this invention, and 402 is the index ellipsoid.

[0015] Moreover, when a liquid crystal display performs a white display and a middle gradation display, the angle of the shaft of the refractive-index anisotropy within a field and the absorption shaft of a polarizing plate to accomplish can be adjusted from a viewpoint which optimizes permeability change, coloring, etc.

[0016]

[Embodiments of the Invention] First, explaining the liquid crystal display of each form avoids, and it performs comprehensive explanation.

[0017] Conditions required for the liquid crystal cell for which this invention is adapted are what "the direction at the time of a black display has [a thing] the value of the local refractive-index anisotropy in a flat surface in general parallel to a liquid crystal cell front face (namely, field it is considered that is abbreviation same orientation when separation orientation of this liquid crystal layer is carried out) smaller than the time of a white display" as they were mentioned above. That is, the liquid crystal cell for which this invention is adapted can be approximated to a positive optically uniaxial phase contrast board, as shown in drawing 2 at the time of a black display. Here, 501 is the lower substrate of a liquid crystal cell, 502 is the upper substrate, and 503 is an index ellipsoid shown on behalf of the refractive-index anisotropy of the liquid crystal layer at the time of a black display.

[0018] In an actual liquid crystal cell, even if it is at the black display time in order to specify the orientation at the time of voltage impression, the index ellipsoid representing a liquid crystal layer has some which incline from [of a substrate] a normal. For example, when 2 ****s of orientation are carried out, as shown in drawing 3 , the major axis of the index ellipsoid of Field A and Field B inclines slightly from the normal on the front face of a substrate. Drawing 3 shows the index ellipsoid representing the refractive-index anisotropy at the time of the black display of the liquid crystal cell which divided the orientation of liquid crystal into two. In this drawing 3 , 521 is Domain B and, for Domain A and 524, a lower substrate and 522 are [an upper substrate and 523 / the index ellipsoid which shows the refractive-index anisotropy of a liquid crystal layer / in / Domain A / in 525], and 526 / index ellipsoids which show the refractive-index anisotropy of the liquid crystal layer in Domain B as for it. In such a case, the difference with

approximation of drawing 2 is expanded in connection with the tilt angle becoming large, and the effect of the invention of this invention decreases. However, with the liquid crystal display generally used, it is a book. Although the below-mentioned example describes, generally a perpendicular orientation film and the liquid crystal display which consists of Nn type liquid crystal have the aforementioned small degree of tilt angle compared with a level orientation film and the liquid crystal display which consists of Np type liquid crystal. That is, this invention demonstrates a bigger effect by applying to a perpendicular orientation film and the liquid crystal display which consists of Nn type liquid crystal.

[0019] As explained above, it is common when [all], as for the essence of this invention, approximation of drawing 2 is materialized in general by the liquid crystal cell at the time of a black display. Therefore, the phase contrast film which has an index ellipsoid equivalent to the index ellipsoid which represents with the following explanation the refractive-index anisotropy of the liquid crystal cell at the time of the black display shown in drawing 2 paying attention to the liquid crystal display at the time of a black display is used instead of a liquid crystal cell, and the content of this invention is explained.

[0020] the composition of the liquid crystal display shown in drawing 4 -- setting -- a liquid crystal cell 105 -- dLC and (nz-nx) =350nm -- nx=ny -- the equipment replaced with the positive optically uniaxial phase contrast film was produced For an upper polarizing plate and 103, as for an upper phase contrast compensation element and 106, in drawing 4 , a lower phase contrast compensation element and 104 are [101 / a lower polarizing plate and 102 / the absorption shaft of a lower polarizing plate and 107] the absorption shafts of an upper polarizing plate. About 108 and 109, it mentions later.

[0021] If it observes changing a viewing angle (theta) along the direction which bisects the absorption shaft of a vertical polarizing plate for the equipment which sandwiched the positive optically uniaxial phase contrast film (the following phi= 45 degrees) with the polarizing plate arranged on the cross Nicol's prism as shown in drawing 5 A, permeability (it was defined as the transverse-plane permeability of only the polarizing plate which carried out parallel Nicol's prism arrangement of the 100% of the permeability drawing) will increase. Namely, optical leakage arises in the liquid crystal cell of a black display state at the time of the tropia. Consequently, contrast falls.

[0022] Furthermore, as everyone knows, as shown in drawing 5 B, the aforementioned phenomenon can improve by using a negative optically uniaxial phase contrast film for the phase contrast compensation elements 103 and 104 shown in drawing 4 . Drawing 5 B is nx=ny>nz as phase contrast compensation elements 103 and 104. df- (nx-nz) (df is the thickness of a phase contrast compensation element) is changed to 0nm - 280nm. It is phi= 45 degrees (absorption shaft orientation of the bottom polarizing plate of a light source side is made into phi= 0 degree), and phi= 90 degrees (direction which is parallel or intersects perpendicularly to the absorption shaft of a vertical polarizing plate), and is the result of measuring the permeability in theta= 50 degrees (direction to which 50 degrees inclined from the normal on the front face of equipment of drawing 4). The permeability of phi= 90 degrees was not based on the value of df (nx-nz), but was about 0%. On the other hand, the permeability of phi= 45 degrees decreases as the value of df (nx-nz) increases from 0, and it takes 2% of minimum values by df(nx-nz) =175. So far, it is common knowledge.

[0023] this invention -- the above -- nx=ny>nz -- a phase contrast compensation element -- nx!=ny and (nx+ny)/2>nz -- the minimum value in phi= 45 degrees is made still smaller than 2% by transposing to a phase contrast compensation element

[0024] Drawing 5 C made each x axis in agreement [the phase contrast compensation elements 103 and 104] with 108 and 109. Considering as nx>ny and the phase contrast compensation element (equivalent to drawing 1) which becomes (nx+ny) / 2>nz, and maintaining df{(nx+ny)/2-nz} =175nm df (nx-ny) is changed to 0nm - 38nm, and it is phi= 45 degrees and phi= 90 degrees, and is the result of measuring the permeability in theta= 50 degrees. In addition, 108 is a shaft in which the maximum refractive index of a lower phase contrast compensation element is shown, and 109 is a shaft in which the maximum refractive index of an upper phase contrast compensation element is shown.

[0025] The permeability of phi= 90 degrees was not based on the value of df (nx-ny), but was about 0%. On the other hand, the permeability of phi= 45 degrees decreased as the value of df (nx-ny) increased from 0, and it became 0.3% of minimum values by df(nx-ny) =20nm.

[0026] That is, as compared with the case of well-known composition, optical leakage (phi= 90 degrees and theta= 50 degrees) has been reduced to one seventh by composition of this invention using the phase contrast compensation element shown in drawing 1 . This effect is immediately connected with the improvement in contrast at the time of the tropia, i.e., the improvement in an angle-of-visibility property. Contrast is because it is proportional to the inverse number of black level.

[0027] It was shown that the optical leakage at the time of observing from across can suppress remarkably towards bisecting the absorption shaft of a vertical polarizing plate especially by choosing the value of nx, ny, and nz appropriately using the phase contrast compensation element which is technique [technique of this invention]

(nx+ny), i.e., nz<,/2, and becomes nx!=ny as shown above. This shows the improvement effect of the angle-of-visibility property of the contrast ratio in the direction which bisects the absorption shaft of a vertical polarizing plate simultaneously.
[0028] Below, the concrete example of this invention is explained.
[0029] (Example 1) The liquid crystal display of the example 1 of this invention was considered as the composition shown in drawing 4 .
[0030] The liquid crystal cell 105 of drawing 4 is the wide-field-of-view angle liquid crystal display mode in which perpendicular orientation of the Nn type liquid crystal proposed [person / invention-in-this-application] was carried out to the shape of an axial symmetry, and is a liquid crystal cell shown in drawing 6 of a Japanese Patent Application No. / No. 341590 / eight to] publication. The composition of this liquid crystal cell 105 is as follows.
[0031] That is, on the substrate 62 by which the transparent electrode 63 (ITO:100nm) was formed in the front face, the photosensitive polyimide was used and the spacer 65 with a height of about 4.5 micrometers was formed outside the picture element field. After that, the heights 66 with a height of about 3 micrometers were formed by OMR83 (Tokyo adaptation shrine make). The size of the field surrounded by heights 66 was set to 100micrometerx100micrometer, and formed this three field in one picture element (100micrometerx300micrometer). Moreover the spin coat of JALS-204 (Japan Synthetic Rubber Co., Ltd. make) was carried out, and the perpendicular orientation layer 68 was formed. Furthermore, the perpendicular orientation layer (not shown) was formed using the material same also on the transparent electrode (it is flat) of another substrate. Both were stuck and the liquid crystal cell was completed.
[0032] Into the produced liquid crystal cell, Nn type liquid crystal material (chiral material is mixed so that MJ95955 by Merck Co. and cell gap 4.5micrometer may make 90 degree twist of left hands) was poured in, and voltage was impressed 7V. Immediately after voltage impression, when the orientation shaft of axial-symmetry orientation changed into the state where more than one exist and the voltage impression state was further continued by the initial state, one axial-symmetry orientation field (monochrome domain) was formed for every field surrounded by heights 66.
[0033] The phase contrast board (thickness df=50micrometer, df(nx-ny) =25nm, and df{(nx+ny)/2-nz} =130nm) produced by the biaxial-stretching method to such a liquid crystal cell has been arranged as shown in drawing 4 as phase contrast compensation elements 103 and 104. Furthermore, outside, polarizing plates 101 and 102 have been arranged so that it may be in a cross Nicol's prism state.
[0034] The angle-of-visibility property of the permeability when indicating the liquid crystal display of this example by black in driver voltage Voff=2V using the optical property measuring instrument LCD 5000 made from Otsuka Electron was measured, the angle-of-visibility property of the permeability at the time of subsequently making it white-display in driver voltage Von=5V was measured, it **(ed) with the permeability of a black display of the permeability at the time of a white display further, and the angle-of-visibility property of a contrast ratio was acquired.
[0035] Drawing 7 is drawing showing contrast contour curves, such as the contrast ratio 50 based on the result.
[0036] (Example 1 of comparison) The example of comparison corresponding to the example 1 of this invention is explained below.
[0037] In this example 1 of comparison, the thing of the same composition as the liquid crystal display shown in drawing 4 was used like the example 1. However, the phase contrast compensation element of a tabular used in this example 1 of comparison was set to thickness df=50micrometer, df(nx-ny) =0nm, and df{(nx+ny)/2-nz} =130nm.
[0038] Drawing 8 is drawing showing contrast contour curves, such as the contrast ratio 50 which measured this liquid crystal display by the same technique as an example 1.
[0039] (Example 2 of comparison) The example of comparison corresponding to the example 1 of this invention is explained below.
[0040] In this example 2 of comparison, the thing of the same composition as the liquid crystal display shown in drawing 4 was used like the example 1. However, the phase contrast compensation element is not used in this example 2 of comparison.
[0041] Drawing 9 is drawing showing contrast contour curves, such as the contrast ratio 50 which measured this liquid crystal display by the same technique as an example 1.
[0042] If drawing 7 , drawing 8 , and drawing 9 which were mentioned above are compared, at phi= 0 degree, 90 degrees, 180 degrees, and 270 degrees, the contrast line, such as contrast 50, all shows the value same in general as theta= 55 degrees. However, a contrast contour curve, such as contrast (phi= 45 degrees, 135 degrees, 225 degrees, and 315 degrees) 50, is theta= 53 degrees in general in drawing 7 of an example 1 as compared with being theta= 38 degrees in general in drawing 9 of the example 2 of comparison at drawing 8 of theta= 23 degrees and the example 1 of comparison.
[0043] If it collects above, in the examples 1 and 2 of comparison, and the example 1, the angle-of-visibility property

in phi= 0 degree, 90 degrees, 180 degrees, and 270 degrees is the same and good in general. However, at phi= 45 degrees, 135 degrees, 225 degrees, and 315 degrees, the angle-of-visibility property of the liquid crystal display of the example 2 of comparison is remarkably inferior. The fixed improvement accomplished the liquid crystal display of the example 1 of comparison to this. Furthermore, in the example 1, this has been improved nearly completely and the angle-of-visibility property of phi= 45 degrees, 135 degrees, 225 degrees, and 315 degrees was expanded to the grade almost equal to the viewing-angle property of phi= 0 degree, 90 degrees, 180 degrees, and 270 degrees. That is, in the example 1, the good angle-of-visibility property was acquired nearly completely isotropic.

[0044] Moreover, in the example 1, as a phase contrast compensation element, although it used one sheet at a time respectively the phase contrast film (thickness df=50micrometer, df(nx-ny) =25nm, and df{(nx+ny)/2-nz} =130nm), as long as this invention shows a property equivalent as a phase contrast compensation element, without being limited to this in any way, you may use it combining two or more phase contrast films or liquid crystal cells etc.

[0045] In (an example 2) and time, the example 1 showed only the case where a liquid crystal cell was inserted with the phase contrast film (phase contrast compensation element) of two sheets which becomes 25nm and df(nx-ny) =df {(nx+ny)/2-nz} =130nm. At this time, each phase contrast compensation element was examination only in the case of having arranged the x axis so that it may intersect perpendicularly with the absorption shaft of the polarizing plate of the nearest neighbors.

[0046] Then, in this example 2, the range from which the effect of this invention is created by making it change independently respectively about the value of df {(nx+ny)/2-nz}, the value of df (nx-ny), and the angle of the absorption shaft of a polarizing plate and the x axis of a phase contrast board to make was estimated. However, in this example 2, instead of using the phase contrast film with which the values of nx, ny, and all nz(es) differ, as shown in drawing 10 , the phase contrast compensation element which combined the 1st phase contrast film of nx=ny>nz and the 2nd phase contrast film of nx>ny=nz was used.

[0047] In drawing 10 a lower polarizing plate and A102 A101 In addition, an upper polarizing plate, The 1st lower phase contrast film (nx=ny>nz) and A104 A103 The 1st upper phase contrast film (nx=ny>nz), The 2nd lower phase contrast film (nx>ny=nz) and A106 A105 The 2nd upper phase contrast film (nx>ny=nz), For a liquid crystal cell and A108, as for the absorption shaft of an upper polarizing plate, and A110, the absorption shaft of a lower polarizing plate and A109 are [A107 / the x axis of the 2nd lower phase contrast film A105 and A111] the x axes of the 2nd upper phase contrast film A106.

[0048] Here, having used the phase contrast compensation element is based on the following two reasons.

(a) Book

(b) It is because it is shown that the effect of this invention can be created also by the phase contrast compensation element which combined two or more phase contrast films.

[0049] arrangement like [change of df(nx-nz)}] drawing 10 -- setting (however, where the 2nd phase contrast film A105 and A106 being removed) -- nx=ny>nz -- df (nx-nz) value of the 1st phase contrast film of thickness df was changed to 20nm - 400nm, and the contrast property of the direction of slant was measured by the same system of measurement as an example 1 Here, the directions of slant are theta= 50 degrees, phi= 0 degree, 45 degrees, 90 degrees, 135 degrees, 180 degrees, 225 degrees, 270 degrees, and 315 degrees in drawing 22 which defined the angle of visibility.

[0050] Drawing 11 is drawing showing the result of measurement.

[0051] At phi= 0 degree, 90 degrees, 180 degrees, and 270 degrees, it is not based on df (nx-nz) value, but the good, almost fixed contrast value is shown so that I may be understood by this drawing 11 . On the other hand, at phi= 45 degrees, 135 degrees, 225 degrees, and 315 degrees, when the value of df (nx-nz) was about 140nm, the greatest contrast was acquired. In addition, also except the aforementioned optimum value, there was an effect of the improvement in contrast in 20 nm<df(nx-nz) <250nm, and also the effect was remarkable in the range which is 90 nm<df(nx-nz) <190nm as shown in drawing 11 .

[0052] As everyone knows, the relative value to dLC and ** n value of the liquid crystal cell compensated (product of Cell thick dLC and **n (=|ne-no|) of the used liquid crystal) should discuss the retardation value {df (nx-nz)} of a phase contrast compensation element. this example 2 also follows the idea. Since **n of the liquid crystal (MJ95955 by Merck Co.) used by this example 2 is 0.077 and cell ** is 4.5 micrometers in general, dLC and **n of a liquid crystal cell are 347nm. therefore, 40% of case can expect in general the effect that it is for 25% - 55% that the retardation value {=df (nx-nz)} of a phase contrast compensation element is between 0% - 72% of dLC and ** n value of a liquid crystal cell, and a remarkable effect is acquired, and the range from which the effect of this invention is acquired is the maximum

[0053] What is necessary is to be the case where the phase contrast compensation element has been arranged on both sides of a liquid crystal cell, and just to carry out abbreviation double precision of each aforementioned value

respectively in this example 2, when it has arranged to single-sided one side. in this case, in the range from which the effect of this invention is acquired, it becomes 80% that the effect that it is for 50% - 110% that the retardation value {df (nx-nz)} of a phase contrast compensation element is between 0% - 144% of dLC and ** n value of a liquid crystal cell, and a remarkable effect is acquired, and it is the maximum is expectable in general

[0054] Although the phase contrast film of two sheets constituted each of a phase contrast compensation element from this example 2, a phase contrast compensation element may consist of things other than the phase contrast film of three or more sheets, or a film, for example, a liquid crystal cell, a mesomorphism poly membrane, etc.

[0055] [(df (nx-ny) value of the 2nd phase contrast film of the thickness df it is thin nx>ny=nz was changed to 0nm - 50nm by change] of df (nx-ny), next arrangement of drawing 10 , and the contrast property of the direction of slant was measured by the same system of measurement as an example 1.) However, the 1st phase contrast film was set to df(nx-nz) =140nm. Here, the directions of slant are theta= 50 degrees, phi= 0 degree, 45 degrees, 90 degrees, 135 degrees, 180 degrees, 225 degrees, 270 degrees, and 315 degrees in drawing 22 which defined the angle of visibility.

[0056] Drawing 12 is drawing showing the result of the measurement.

[0057] At phi= 0 degree, 90 degrees, 180 degrees, and 270 degrees, it is not based on df (nx-ny) value, but the good, almost fixed contrast value is acquired so that I may be understood by this drawing 12 . On the other hand, at phi= 45 degrees, 135 degrees, 225 degrees, and 315 degrees, when the value of df (nx-ny) was about 22.5nm, the greatest contrast was acquired. In addition, also except the optimum value of 22.5nm, there was an effect of the improvement in contrast in 2.5 nm<df(nx-ny) <45nm, and also the effect was remarkable in the range which is 10 nm<df(nx-ny) <35nm as shown in drawing 12 .

[0058] Here, the relative value to dLC and ** n value of the liquid crystal cell compensated (in the case of this example dLCand** n= 347nm) discusses the retardation value {df (nx-ny)} of a phase contrast compensation element.

[0059] 6.5% of case can expect in general the effect that it is for 2% - 10% that the retardation value {df (nx-ny)} of a phase contrast compensation element is between 0% - 13% of dLC and ** n value of a liquid crystal cell, and a remarkable effect is acquired, and the range from which the effect of this invention is acquired is the maximum

[0060] The x axis of the phase contrast compensation element arranged to the upper and lower sides of a liquid crystal cell is made to have intersected perpendicularly in general in the [angle which x-axis (shaft in which maximum refractive index is shown in field) shaft of vertical phase contrast compensation element accomplishes] this invention. The reason is for avoiding the fall of the contrast when seeing a liquid crystal display from a transverse plane. If the x axis of the phase contrast compensation element of two sheets does not lie at right angles, since the phase contrast within a field arises with the whole phase contrast compensation element, it is because it can guess easily that a good black display is not obtained but contrast falls.

[0061] In the example 1 which carried out [change of angle which arrangement [of a phase contrast compensation element], and x-axis and absorption shaft of polarizing plate accomplish] above-mentioned, the x axis (shaft in which the maximum refractive index is shown) of the phase contrast compensation element arranged to the upper and lower sides of a liquid crystal cell was arranged at the rectangular cross on the absorption shaft of the polarizing plate which carried out the nearest neighbors to it. In this example 2, the gap of the orthogonality relation of a x axis and the absorption shaft of the polarizing plate of the nearest neighbors and the relation of the effect of this invention were investigated.

[0062] The phase contrast film which specifically fulfills the conditions of df(nx-nz) =140nm and ny=nx (1st phase contrast film), df(nx-ny) =22.5nm and the phase contrast film (2nd phase contrast film) which fulfills the conditions of nz=ny Maintaining the orthogonality relation of x shafts each of the 2nd phase contrast film which carried out the laminating like drawing 10 and which was allotted up and down (shaft parallel to the maximum refractive index in a field) The angle alpha of the x axis of the 2nd phase contrast film and the absorption shaft of the polarizing plate of the nearest neighbors (refer to drawing 13) to accomplish was changed in 0 degree <= alpha< 180 degrees by having made clockwise rotation positive, and the contrast property of the direction of slant was measured by the same system of measurement as an example 1. Here, the directions of slant are theta= 50 degrees, phi= 0 degree, 45 degrees, 90 degrees, 135 degrees, 180 degrees, 225 degrees, 270 degrees, and 315 degrees in drawing 22 which defined the angle of visibility.

[0063] Drawing 14 is drawing showing a measurement result.

[0064] Although phi= 0 degree, 90 degrees, 180 degrees, and 270 degrees of maximums are taken by three points, alpha= 0 degree, 90 degrees, and 180 degrees, when based on this drawing 14 , phi= 45 degrees, 135 degrees, 225 degrees, and 315 degrees take maximum only by the arrangement with which it is only alpha= 90 degrees, namely, the absorption shaft of a nearest-neighbors polarizing plate and the x axis of a phase contrast compensation element cross at right angles.

[0065] therefore, in order to acquire the effect of this invention to the maximum extent, it is a time of the shaft nx in

which the maximum refractive index in the field of alpha= 90 degrees, i.e., a phase contrast compensation element, is shown, and the absorption shaft of the polarizing plate of the nearest neighbors crossing at right angles at it Moreover, according to drawing 14 , it is at the time of 45 degrees < alpha< 135 degrees, i.e., the aforementioned book. Furthermore, by the case where 23 degrees shifts to a clockwise rotation and a counterclockwise rotation, the remarkable effect was acquired from the arrangement from which the maximum effect of the time of 67 degrees < alpha< 113 degrees, i.e., the aforementioned this invention, is acquired.

[0066] Although the thing of composition of being shown in drawing 6 as liquid crystal display mode was used in the examples 1 and 2, the liquid crystal display mode which can apply this invention is not limited to this at all. That is, as long as it is the liquid crystal cell which fulfills conditions according to claim 1, the liquid crystal cell using what display mode is sufficient.

[0067] (Example 3) It was an example at the time of being adapted in the phase contrast compensation technology of this invention to the typical liquid crystal display mode to which division orientation of the Nn type liquid crystal which carried out perpendicular orientation in the examples 1 and 2 mentioned above was carried out. In this example 3 and the below-mentioned example 4, it is adapted in the phase contrast compensation technology of this invention to the typical liquid crystal display mode to which division orientation of the Np type liquid crystal which carried out level orientation was carried out.

[0068] It is the same as that of what also shows the composition of the liquid crystal display of this example 3 to drawing 4 .

[0069] The liquid crystal cell of drawing 4 is the thing in wide-field-of-view angle liquid crystal display mode which carried out level orientation of the Np type liquid crystal proposed [person / invention-in-this-application] to the shape of an axial symmetry. It will be as follows if an example of the method of producing the liquid crystal cell is given. Of course, the producing method is not limited to this.

[0070] The manufacture method of the liquid crystal display of this example is explained referring to above-mentioned drawing 6 .

[0071] On the substrate 62 by which the transparent electrode 63 (100nm of ITO= thickness) was formed in the front face, the photosensitive polyimide was used and the spacer 65 with a height of about 4.5 micrometers was formed outside the picture element field. The heights 66 with a height of about 3 micrometers were formed by OMR83 (Tokyo adaptation make) after that. The size of the field surrounded by heights 66, i.e., a picture element field, was made into 100micrometer**. The perpendicular orientation layer 68 is not formed.

[0072] Thus, it stuck with the substrate of the configuration flat [having a transparent electrode] which is another substrate about the formed substrate, and the liquid crystal cell was completed.

[0073] Into the produced liquid crystal cell, the mixture which mixed MS90847 (Merck Co. make : S811 0.4-% of the weight ****) 3.74g and 0.025g of optical initiators Irgacure651 as p-phenyl styrene 0.1g and a liquid crystal material as R-684 (Nippon Kayaku make) 0.1g and a photopolymerization inhibitor as a photoresist was poured in.

[0074] Then, the liquid crystal cell was heated at 110 degrees C more than the clearing point temperature of liquid crystal, and was held for 1 hour. Then, it cooled slowly to the room temperature by 0.1 degrees C/min. Voltage impression was stopped and annealing was resumed, after having observed the transparent phase and the un-transparent phase in the picture element, and having stopped annealing, having impressed the square wave of about 2.5 Vrms(es) to the liquid crystal cell intermittently in the middle of annealing, when the area of a transparent phase and an un-transparent phase became almost the same, and acquiring taking up and down and good axial-symmetry orientation for the temperature of a cell appropriately. Axial-symmetry orientation was fixed by irradiating ultraviolet rays and finally, stiffening a photoresist R-684, and production of a liquid crystal cell was completed.

[0075] The phase contrast films 103 and 104 as a phase contrast compensation element (thickness df=50micrometer, df (nx-ny) =25nm, and df{(nx+ny)/2-nz} =130nm) produced by the biaxial-stretching method to this liquid crystal cell have been arranged like drawing 4 . Furthermore, polarizing plates 101 and 102 have been arranged on the outside, and the liquid crystal display was completed.

[0076] The angle-of-visibility property of the permeability when indicating the liquid crystal display of this example 3 by black in driver voltage Von=7.3V using the optical property measuring instrument LCD 5000 made from Otsuka Electron was measured, the angle-of-visibility property of the permeability at the time of subsequently making it white-display in driver voltage Voff=2.3V was measured, it **(ed) with the permeability of a black display of the permeability at the time of a white display further, and the angle-of-visibility property of a contrast ratio was acquired.

[0077] Drawing 15 is drawing showing contrast contour curves, such as a contrast ratio 5, based on the result.

[0078] (Example 3 of comparison) The example 3 of comparison corresponding to the example 3 of this invention is explained below.

[0079] In this example 3 of comparison, the thing of the composition of the liquid crystal display shown in drawing 4

was used like the example 3. However, the phase contrast board used in this example 3 of comparison was set to thickness df=50micrometer, df(nx-ny) =0nm, and df{(nx+ny)/2-nz} =130nm.
[0080] Drawing 16 is drawing showing contrast contour curves, such as the contrast ratio 5 which measured this liquid crystal display by the same technique as an example 1.
[0081] (Example 4 of comparison) The example 4 of comparison corresponding to the example 3 of this invention is explained below.
[0082] In this example 4 of comparison, the thing of the composition of the liquid crystal display shown in drawing 4 was used like the example 3. However, the phase contrast compensation element is not used in this example 4 of comparison.
[0083] Drawing 17 is drawing showing contrast contour curves, such as the contrast ratio 5 which measured this liquid crystal display by the same technique as an example 1.
[0084] If drawing 15 , drawing 16 , and drawing 17 </A> which were mentioned above are compared, at phi= 0 degree, 90 degrees, 180 degrees, and 270 degrees, the contrast line, such as contrast 5, all shows the value same in general as theta= 60 degrees. However, a contrast contour curve, such as contrast (phi= 135 degrees and 315 degrees) 5, is theta= 55 degrees in general in drawing 15 of an example 3 as compared with being theta= 48 degrees in general in drawing 17 of the example 4 of comparison at drawing 16 of theta= 38 degrees and the example 3 of comparison.
[0085] If it collects above, in the examples 3 and 4 of comparison, and the example 3, the angle-of-visibility property in phi= 0 degree, 90 degrees, 180 degrees, and 270 degrees is the same and good in general. However, at phi= 135 degrees and 315 degrees, the angle-of-visibility property of the liquid crystal display of the example 4 of comparison is inferior. The fixed improvement accomplished the liquid crystal display of the example 3 of comparison to this. Furthermore, in the example 3, this has been improved nearly completely and the angle-of-visibility property of phi= 135 degrees and 315 degrees was expanded to phi= 0 degree, 90 degrees, 180 degrees, and the grade with almost equal 270 degrees. That is, in the example 3, the good angle-of-visibility property was acquired nearly completely isotropic.
[0086] Although the phase contrast film of two sheets constituted the phase contrast compensation element from this example, you may constitute from things other than the film or film of two or more sheets, for example, a liquid crystal cell, a mesomorphism poly membrane, etc.
[0087] (The example 4) and the example 3 mentioned above in time showed only the case where a liquid crystal cell was inserted with the phase contrast film of two sheets which becomes 25nm and df(nx-ny) =df{(nx+ny)/2-nz} =130nm. At this time, each phase contrast board was examination only in the case of having arranged the x axis so that it may intersect perpendicularly with the absorption shaft of the polarizing plate of the nearest neighbors.
[0088] Then, in this example 4, the range from which the effect of this invention is created by making it change independently respectively about the value of df {(nx+ny)/2-nz}, the value of df (nx-ny), and the angle of the absorption shaft of a polarizing plate and the x axis of a phase contrast board to accomplish was estimated. However, in this example 4, the phase contrast compensation element which combined the 1st phase contrast film of nx=ny>nz and the 2nd phase contrast film of nx>ny=nz like drawing 10 has been arranged instead of using the phase contrast film with which all the values of nx, ny, and nz differ. The method of arrangement is the same as that of the case of an example 2.
[0089] Here, having used this phase contrast compensation element is based on the following two reasons.
(a) Book
(b) It is because it is shown that the effect of this invention can be created also by the phase contrast compensation element which combined two or more phase contrast films.
[0090] In arrangement like [change of df (nx-nz)] drawing 10 , df (nx-nz) value of the phase contrast film of the thickness df it is thin nx=ny>nz was changed to 20nm - 400nm, and the contrast property of the direction of slant was measured by the same system of measurement as an example 1. Here, the directions of slant are theta= 50 degrees, phi= 0 degree, 45 degrees, 90 degrees, 135 degrees, 180 degrees, 225 degrees, 270 degrees, and 315 degrees in drawing 22 which defined the angle of visibility.
[0091] Drawing 18 is drawing showing the result of measurement.
[0092] In drawing 18 , at phi= 0 degree, 90 degrees, 180 degrees, and 270 degrees, it is not based on df (nx-nz) value, but the good, almost fixed contrast value is shown. On the other hand, at phi= 45 degrees, 135 degrees, 225 degrees, and 315 degrees, when the value of df (nx-nz) was about 150nm, the greatest contrast was acquired. In addition, in 20 nm<df(nx-nz) <300nm, there was an effect of the improvement in contrast also except the aforementioned optimum value, and also the effect was remarkable in the range which is 70 nm<df(nx-nz) <230nm as shown in drawing 18 .
[0093] As everyone knows, the relative value to dLC and ** n value of the liquid crystal cell compensated (product of Cell thick dLC and **n (=|ne-no|) of the used liquid crystal) should discuss the retardation value {df (nx-nz)} of a phase contrast compensation element. this example also follows the idea. It follows. since **n of the liquid crystal

(MS90847 by Merck Co.) used by this example is 0.096 and cell ** is 4.5 micrometers in general, dLC and **n of a liquid crystal cell are 432nm -- 35% of case can expect in general the effect that it is 16% - 54% that the retardation value {df (nx-nz)} of a phase contrast compensation element of the range from which the effect of this invention is acquired is between 5% - 69% of dLC and ** n value of a liquid crystal cell, and a remarkable effect is acquired, and it is the maximum

[0094] What is necessary is to be the case where the phase contrast compensation element has been arranged on both sides of a liquid crystal cell, and just to carry out abbreviation double precision of each aforementioned value respectively in this example, when it has arranged in one of the two. therefore, it becomes 70% that the effect that it is for 32% - 108% that the retardation value {=df (nx-nz)} of a phase contrast compensation element of the range from which the effect of this invention is acquired is between 10% - 138% of dLC and ** n value of a liquid crystal cell, and a remarkable effect is acquired, and it is the maximum is expectable in general

[0095] [change of df (nx-ny)], next arrangement of drawing 10 -- nx>ny=nz -- df (nx-ny) value of the phase contrast films A105 and A106 of thickness df was changed to 3nm - 50nm, and the contrast property of the direction of slant was measured by the same system of measurement as an example 1 However, the phase contrast films A103 and A104 are df(nx-nz) =150nm. Here, the directions of slant are theta= 50 degrees, phi= 0 degree, 45 degrees, 90 degrees, 135 degrees, 180 degrees, 225 degrees, 270 degrees, and 315 degrees in drawing 22 which defined the angle of visibility.

[0096] Drawing 19 is drawing showing the result of measurement.

[0097] According to drawing 19 , at phi= 0 degree, 90 degrees, 180 degrees, and 270 degrees, it is not based on df (nx-ny) value, but the good, almost fixed contrast value is acquired. On the other hand, at phi= 45 degrees, 135 degrees, 225 degrees, and 315 degrees, a big difference is in df (nx-ny) value which gives the maximum contrast in phi= 45 degrees, 225 degrees, phi= 135 degrees, and 315 degrees. However, change of the contrast of both the groups to df (nx-ny) value change is broadcloth, and when both contrast is in agreement (this is also one of the effects of this invention) (i.e., even when an angle-of-visibility property becomes concentric circle-like more), the effect of contrast expansion is fully acquired. The value of df (nx-ny) at this time was 24nm, and the effect of this invention was the maximum at this time. In addition, in 3 nm<df(nx-ny) <48nm, there was an effect of this invention also except the optimum value of 24nm, and the effect was still more remarkable in the range which is 12 nm<df(nx-ny) <36nm as shown in drawing 19 .

[0098] Here, the relative value to dLC and ** n value of the liquid crystal cell compensated (dLC and **n=432nm in the case of this example) discusses the retardation value {df (nx-ny)} of a phase contrast compensation element. 5.5% of case can expect in general the effect that it is for 2% - 9% that the retardation value {df (nx-ny)} of a phase contrast compensation element of the range from which the effect of this invention is acquired is between 0% - 12% of dLC and ** n value of a liquid crystal cell, and a remarkable effect is acquired, and it is the maximum

[0099] The x axis of the phase contrast compensation element arranged to the upper and lower sides of a liquid crystal cell is made to have intersected perpendicularly in general in the [angle which x axis (shaft in which maximum refractive index is shown in field) of vertical phase contrast compensation element accomplishes] this invention. The reason is for avoiding the fall of the contrast when seeing a liquid crystal display element from a transverse plane. If the x axis of the phase contrast compensation element of two sheets does not lie at right angles, since the phase contrast within a field arises with the whole phase contrast compensation element, it is because it can guess easily that a good black display is not obtained but contrast falls.

[0100] The absorption shaft of the polarizing plate which carried out the nearest neighbors to it, and the x axis (shaft in which the maximum refractive index is shown) of the phase contrast compensation element arranged to the upper and lower sides of a liquid crystal cell were made to have crossed at right angles in the example 3 which carried out [change of angle which arrangement [of a phase contrast compensation element], and x-axis and absorption shaft of polarizing plate accomplish] above-mentioned. In this example 4, the gap of the orthogonality relation of a x axis and the absorption shaft of the polarizing plate of the nearest neighbors and the relation of the effect of this invention were investigated.

[0101] The phase contrast film which specifically fulfills the conditions of df(nz-nx) =150nm and ny=nx, Maintaining the orthogonality relation of the x axis (shaft parallel to the maximum refractive index in a field) of the phase contrast compensation element which carried out the laminating of the phase contrast film of two sheets with df(nx-ny) =24nm and the phase contrast film which fulfills the conditions of nz=ny like drawing 10 The angle alpha of the x axis of a phase contrast compensation element and the absorption shaft of the polarizing plate of the nearest neighbors (refer to drawing 13) to accomplish was changed in 0 degree <= alpha< 180 degrees by having made clockwise rotation positive, and the contrast property of the direction of slant was measured by the same system of measurement as an example 1. Here, the directions of slant are theta= 50 degrees, phi= 0 degree, 45 degrees, 90 degrees, 135 degrees, 180 degrees, 225 degrees, 270 degrees, and 315 degrees in drawing 22 which defined the angle of visibility.

[0102] Drawing 20 is drawing showing a measurement result.
[0103] According to drawing 20 , the value of alpha which gives the greatest contrast to all phi does not exist. However, it is that an angle-of-visibility property can be expanded symmetrically at the time in the arrangement with which the absorption shaft of a nearest-neighbors polarizing plate and the x axis of alpha= 90 degrees, i.e., a phase contrast compensation element, cross at right angles. therefore, it is a time of the shaft nx in which the maximum refractive index in the field of alpha= 90 degrees, i.e., a phase contrast compensation element, is shown in order to acquire the effect of this invention to the maximum extent, and the absorption shaft of the polarizing plate of the nearest neighbors crossing at right angles at it Moreover, according to drawing 20 , it is at the time of 45 degrees < alpha< 135 degrees, i.e., the aforementioned book. Furthermore, by the case where 23 degrees shifts to a clockwise rotation and a counterclockwise rotation, the remarkable effect was acquired from the arrangement from which the maximum effect of the time of 67 degrees < alpha< 113 degrees, i.e., the aforementioned this invention, is acquired.
[0104] Although the display mode with which orientation is changing to the abbreviation continuation target as the liquid crystal cell, i.e., the liquid crystal display mode, of the composition of drawing 6 (orientation division was carried out continuously) was used in the examples 1-4 mentioned above, as mentioned above, the scope of this invention is not limited to this at all.
[0105] Improving the angle-of-visibility property in the direction which shifted from the absorption shaft of a polarizing plate 45 degrees by this invention used the display mode with which orientation is changing to the abbreviation continuation target by this example, and it is because an isotropic angle-of-visibility property is acquired.
[0106] An example of the director distribution in a picture element when seeing the liquid crystal display in the division orientation of two division, quadrisection, and continuation division from a transverse plane to drawing 21 is shown. (a-1) is the case where (c-2) performs a black display by continuation orientation, when performing a white display by 2 division orientation, (a-2) performs a black display by 2 division orientation, (b-1) performs a white display by quadrisection orientation, (b-2) performs a black display by quadrisection orientation, and (c-1) performs a white display by continuation orientation. The dashed line in these drawings shows each domain boundary by division orientation. Moreover, the arrow in drawing shows the director of a liquid crystal molecule by making the rising direction of the liquid crystal molecule in the interlayer of a liquid crystal cell into when, as shown in drawing 21 (d).
[0107] When orientation is changing continuously so that I may be understood from this drawing 21 (orientation division was carried out continuously), a thing without this boundary line is the feature. In addition, in drawing 21 , division nothing, trichotomy, five division, six division, seven division, etc. are considered. Moreover, various twist angles can be taken respectively.
[0108] Moreover, the right column of drawing 21 and the director distribution of the black display which it was got blocked (a-2) and shown in (b-2) and (c-2) show directly that this invention is not based on a display mode (the division method). That is, in a black display, it is not based on the division method, but the director is the same. Strictly, the profiles of the thickness-of-liquid-crystal-cell direction differ. That the property of examples 1 and 2 using the perpendicular orientation of Nn type liquid crystal is excellent as compared with the property of examples 3 and 4 using the level orientation of Np type liquid crystal originates in the difference in the profile of the cell thick direction. The difference in this profile is explained below concretely.
[0109] When Nn type liquid crystal is used, even if it puts on which position of the cell thick direction at the time of a black display (also setting to any near a vertical substrate and near the center of cell **), the liquid crystal molecule is carrying out orientation of the molecule major axis perpendicularly to the substrate front face. On the other hand, although the liquid crystal molecule near the center of cell ** is carrying out orientation of the molecule major axis perpendicularly to the substrate front face at the time of a black display when Np type liquid crystal is used, orientation is carried out to abbreviation parallel to a perpendicular shell gap substrate front face as a vertical substrate is approached. The difference in the above-mentioned profile says the difference in this orientation state. This orientation state is different, and it originates, and in order that the liquid crystal cell using Nn type liquid crystal may present the ideal refractive-index anisotropy represented with the index ellipsoid shown in drawing 2 as compared with the liquid crystal cell which used Np type liquid crystal, the angle-of-visibility property of the liquid crystal display of examples 1 and 2 is superior to the angle-of-visibility property of examples 3 and 4.
[0110] Book That is, rather than the time of a white display, as long as the value of the local refractive-index anisotropy in a flat surface in general parallel to a liquid crystal cell front face is the liquid crystal cell to which the direction at the time of a black display becomes small, it may use the liquid crystal cell using what display mode.
[0111] Although reference is not made at all about the drive method of a liquid crystal display in the example of this invention, it cannot be overemphasized that this invention can be adapted for any drive methods, such as an active matrix drive which used a passive matrix drive, TFT, etc., and a plasma address drive (PALC) using plasma electric discharge.

[0112]
[Effect of the Invention] since it is possible to offer the liquid crystal display which cancels aggravation of the angle-of-visibility property accompanying the gap from an absorption shaft, and has the angle-of-visibility property of an axial symmetry in general when being based on this invention, as explained in full detail above -- an angle of visibility -- remarkable -- expandable -- and this property -- an omnidirection -- crossing -- abbreviation -- isotropic -- making -- things become possible

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[Translation done.]

* NOTICES *

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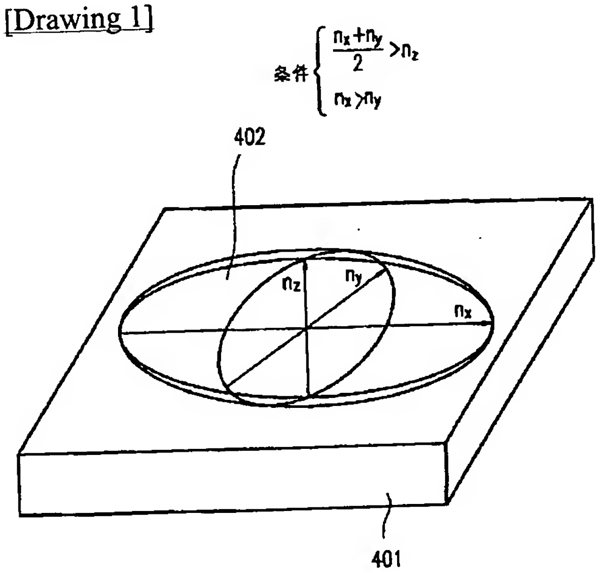
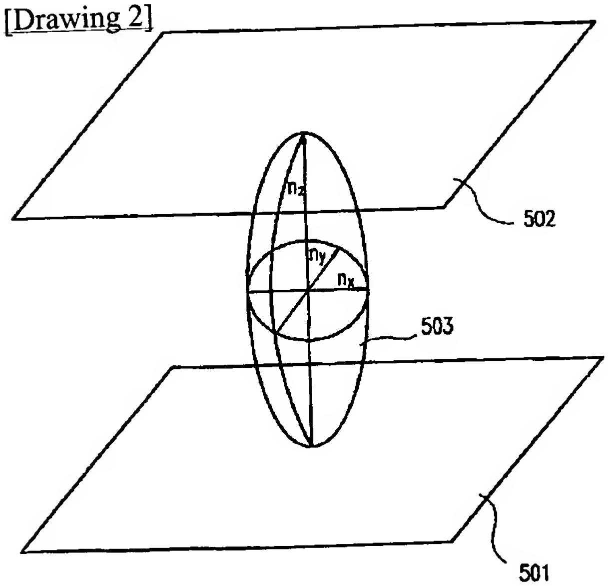
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

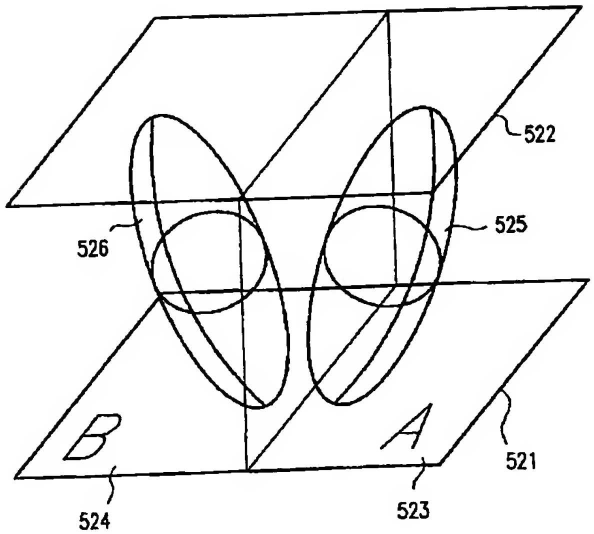
[Drawing 1]



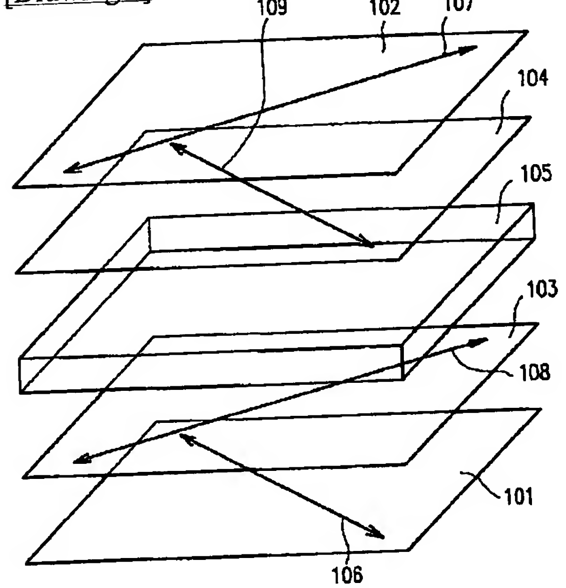
[Drawing 2]



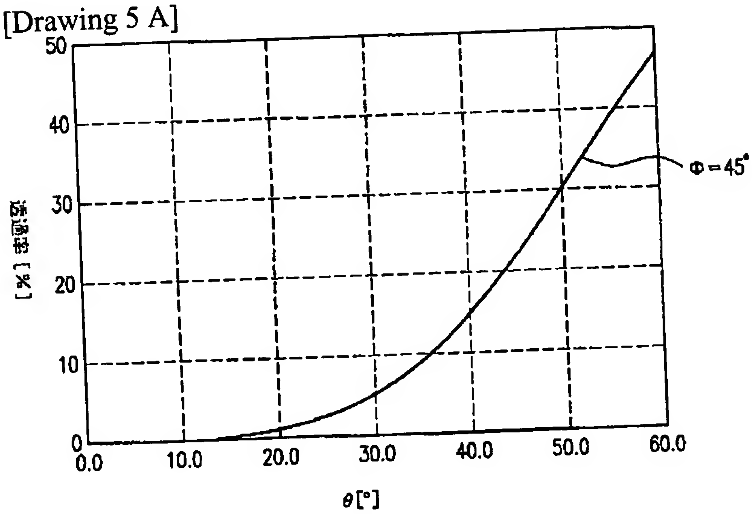
[Drawing 3]



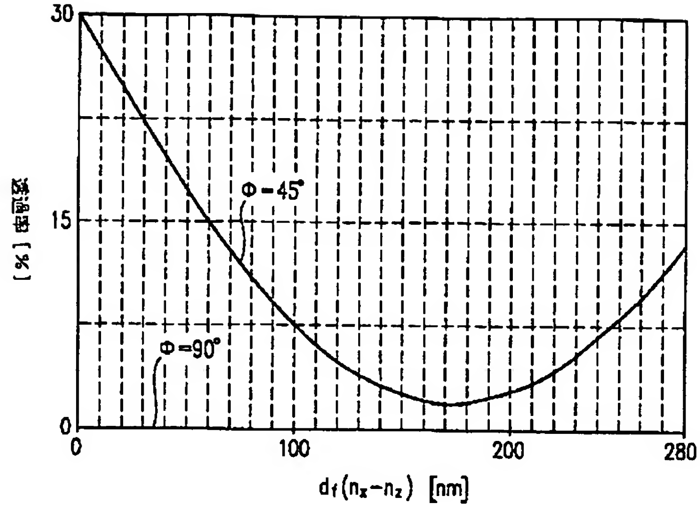
[Drawing 4]



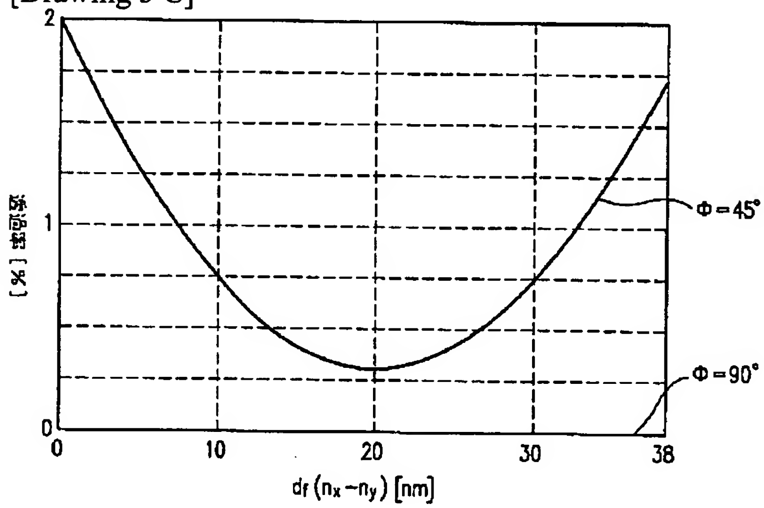
[Drawing 5 A]



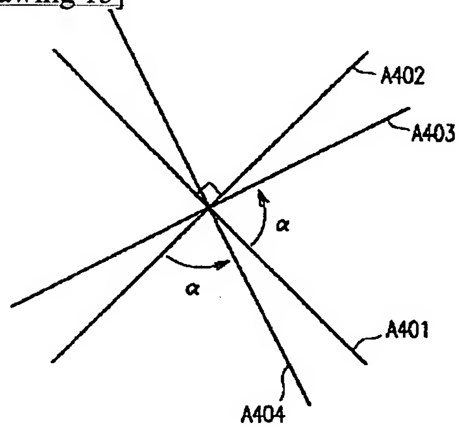
[Drawing 5 B]



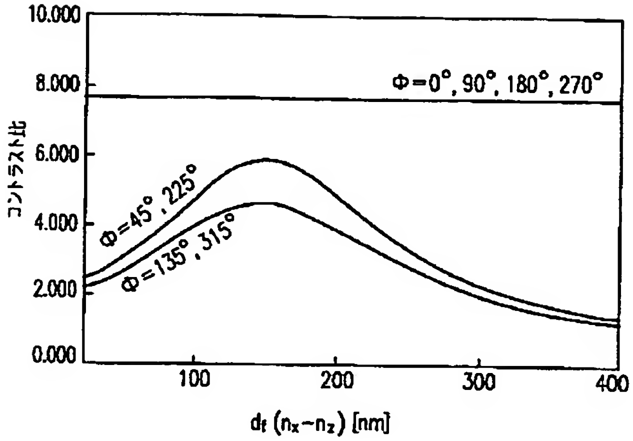
[Drawing 5 C]



[Drawing 13]

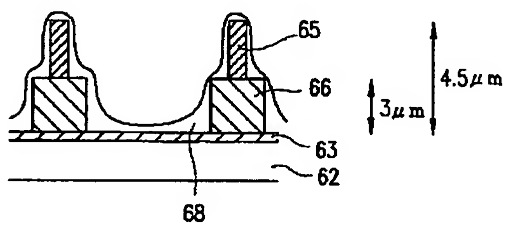


[Drawing 18]

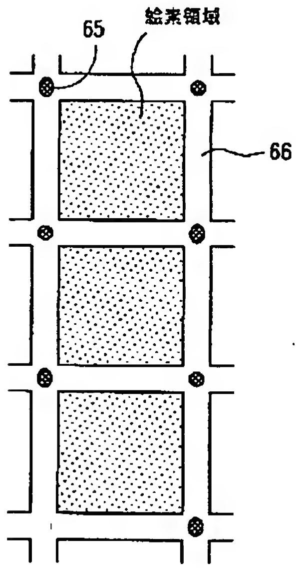


[Drawing 6]

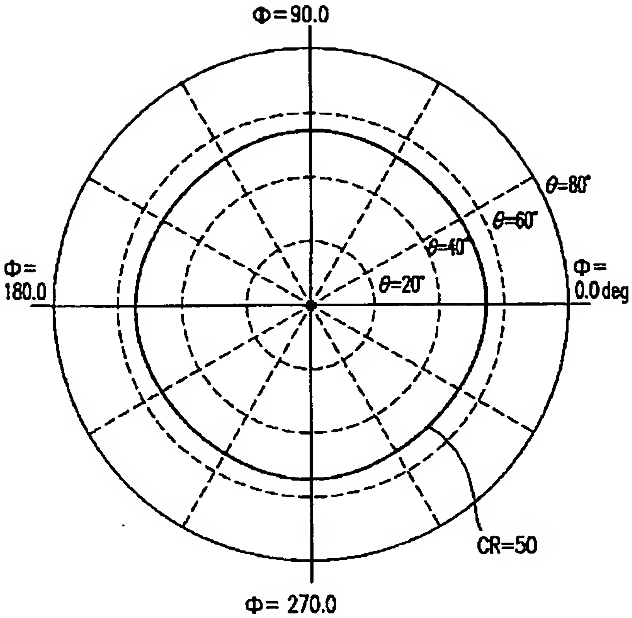
(a)



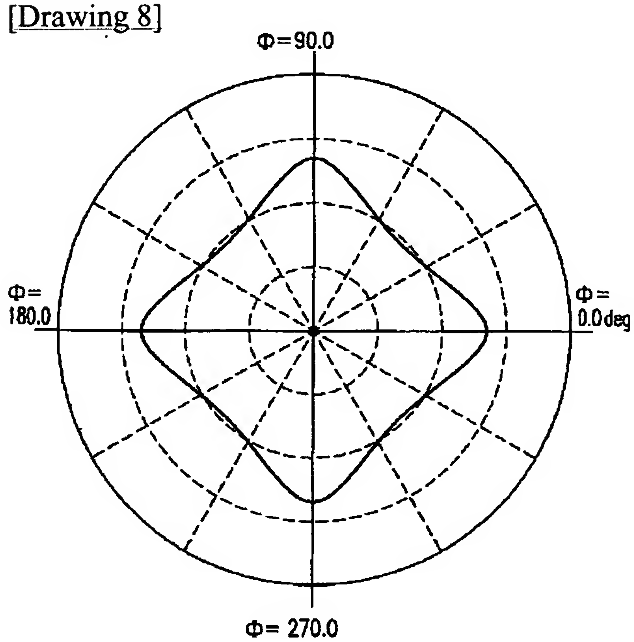
(b)



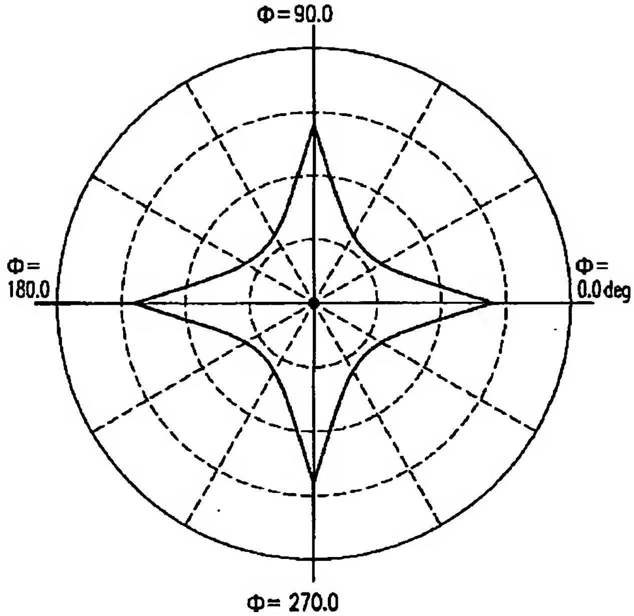
[Drawing 7]



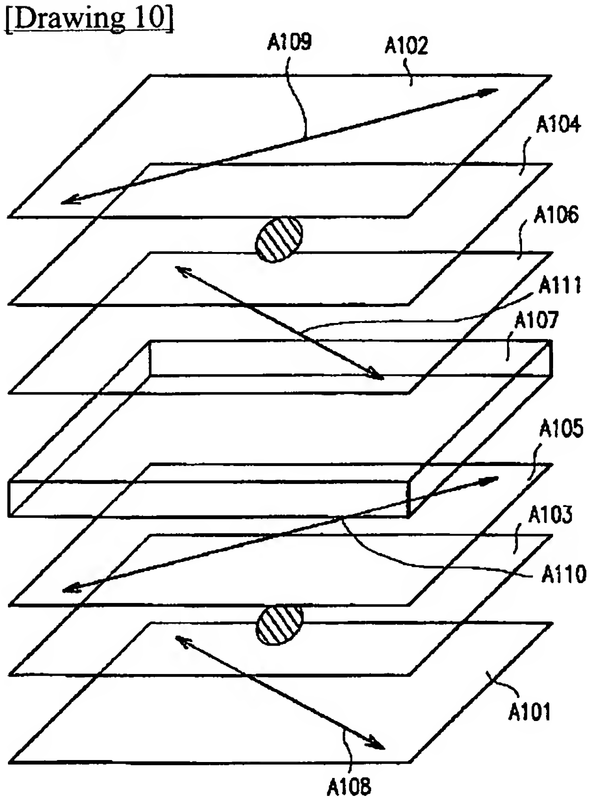
[Drawing 8]



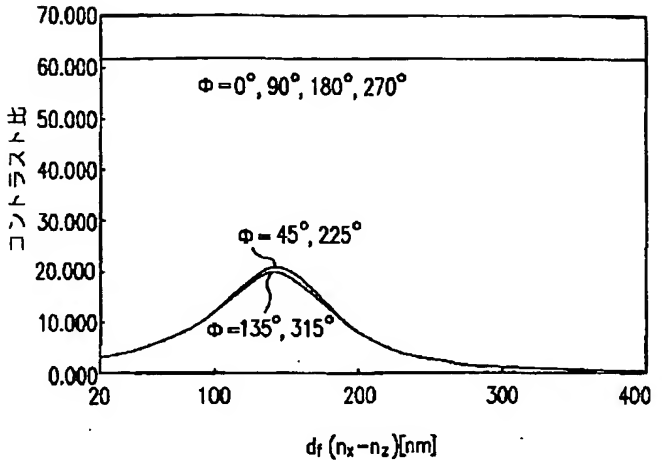
[Drawing 9]



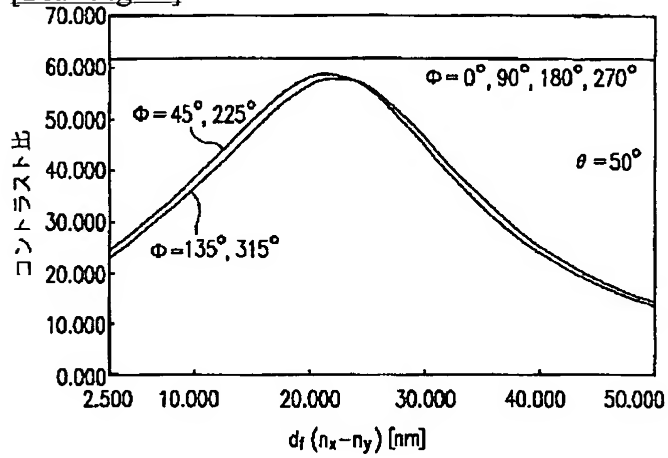
[Drawing 10]



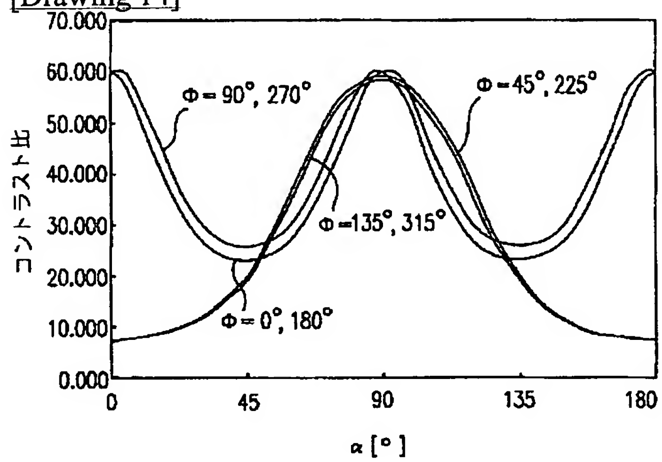
[Drawing 11]



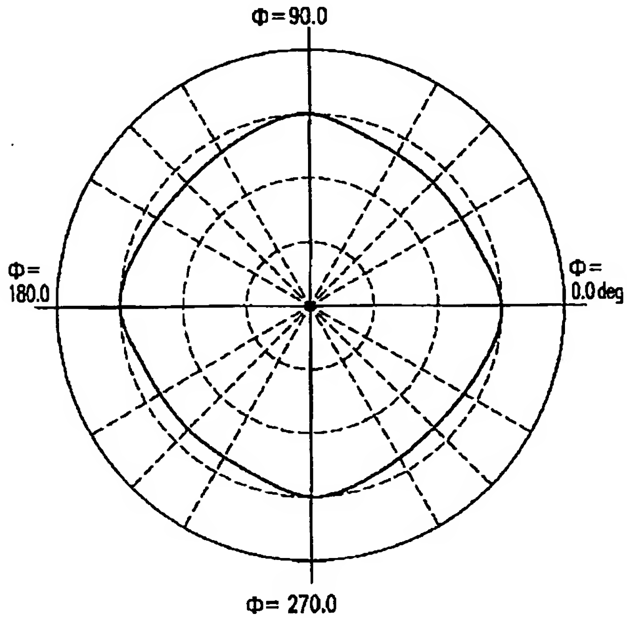
[Drawing 12]



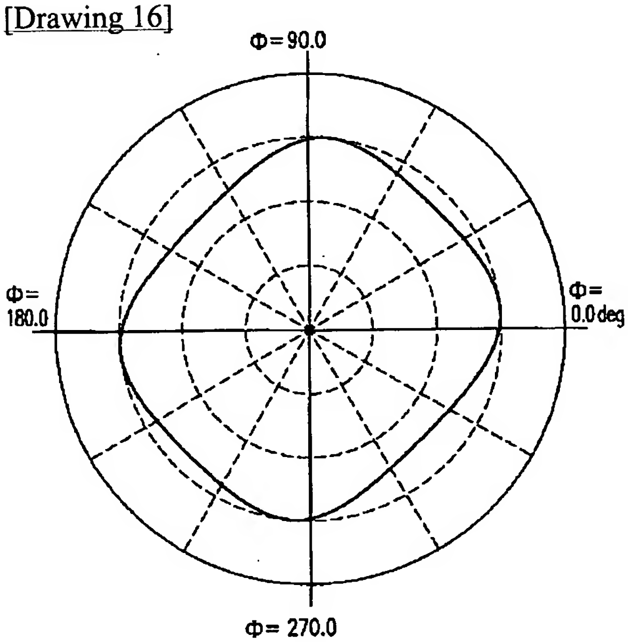
[Drawing 14]



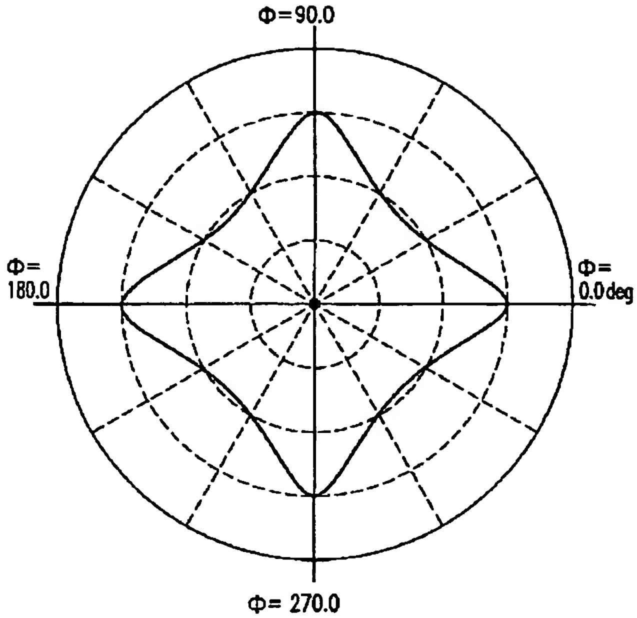
[Drawing 15]



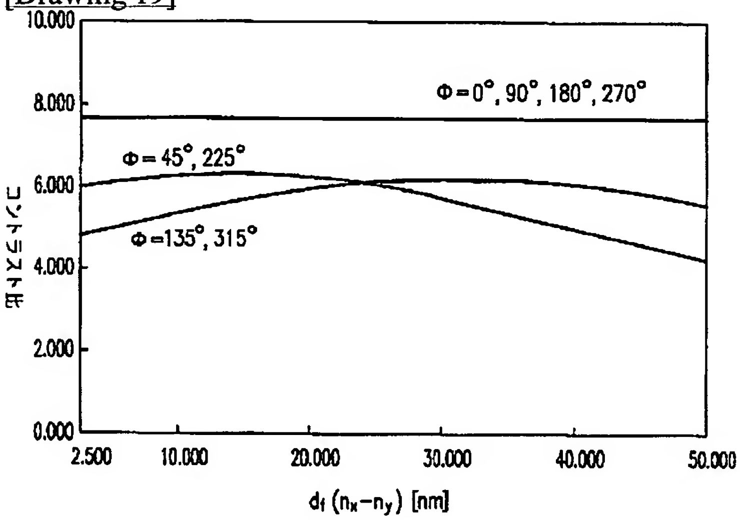
[Drawing 16]



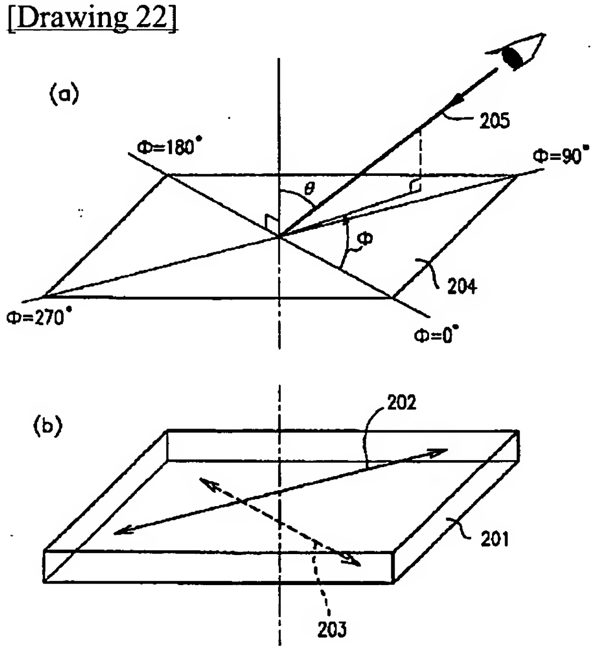
[Drawing 17]



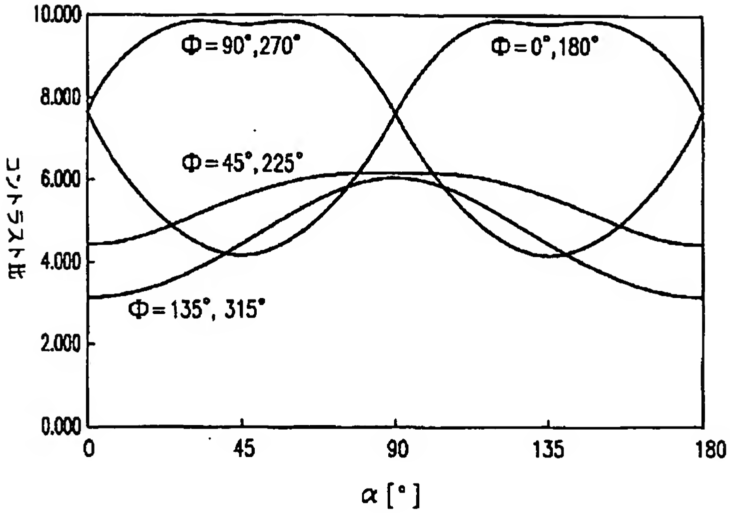
[Drawing 19]



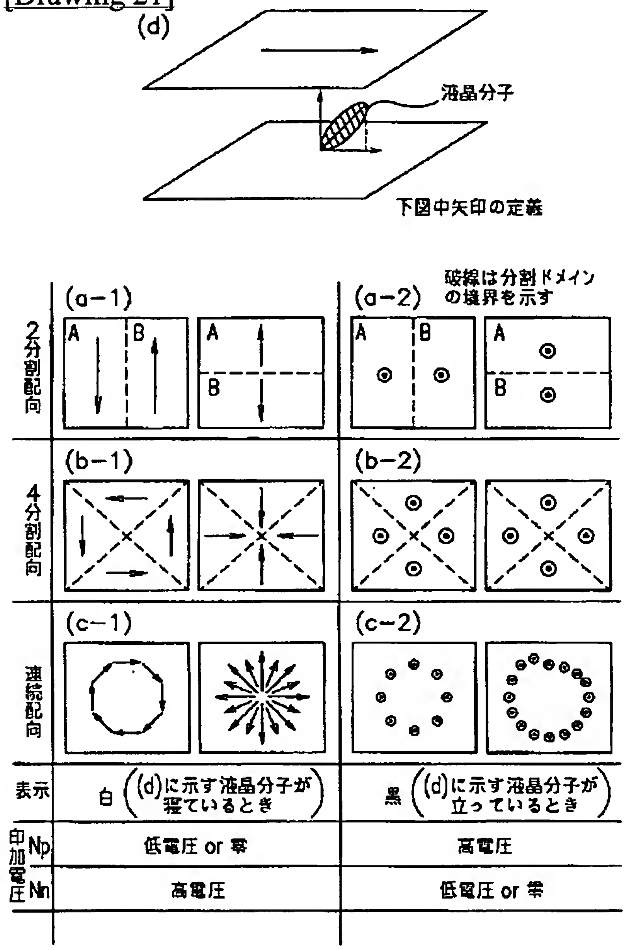
[Drawing 22]



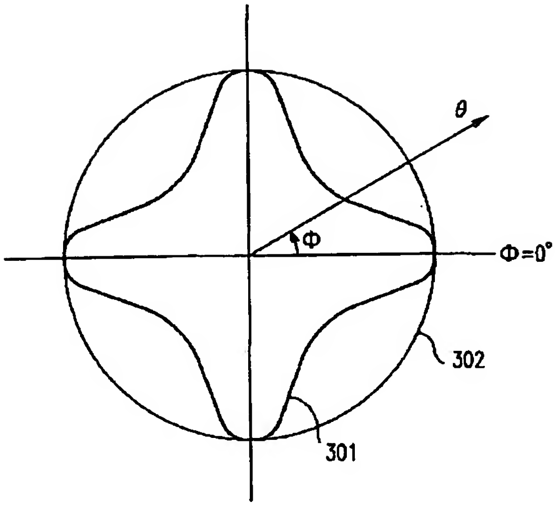
[Drawing 20]



[Drawing 21]



[Drawing 23]



[Translation done.]